Using the TPM

It‘s Not Rocket Science (Anymore)

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2020-10-27

Hello World!

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TPM – Why Even Bother?

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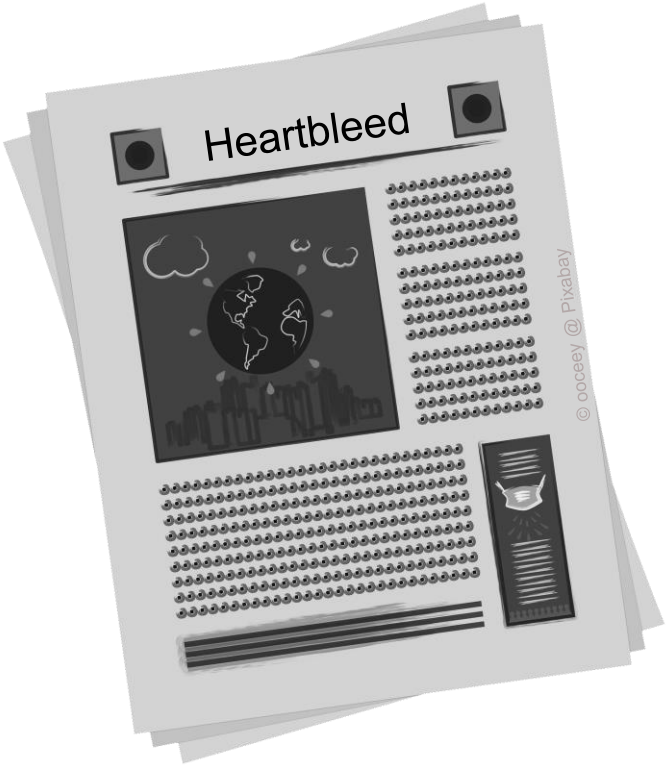

TPM – Why Even Bother?

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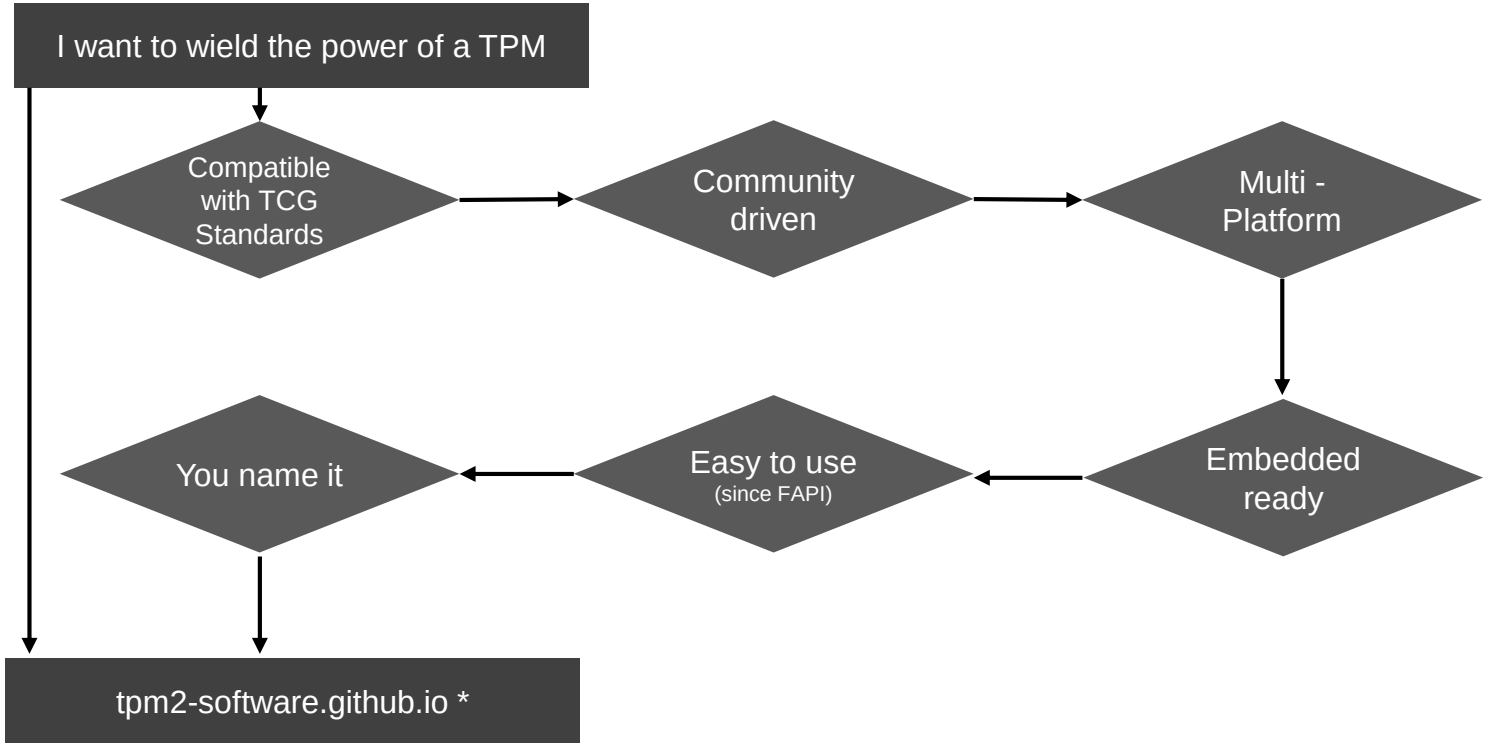
TPM – Why Even Bother?

- Trusted Platform Module
  - **Open Standard**
  - Open Source Ecosystem
  - In virtually **every** consumer device!

Trusted Platform Module

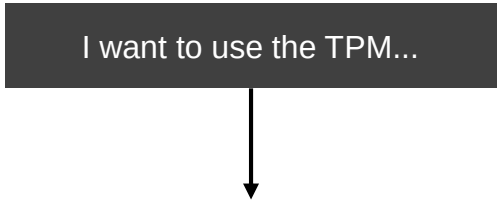
- Powerful Authorization Model
- Platform Configuration Registers
- Secure Key Storage
- True Random Number Generator

Path to Power – TPM2 Software Stack

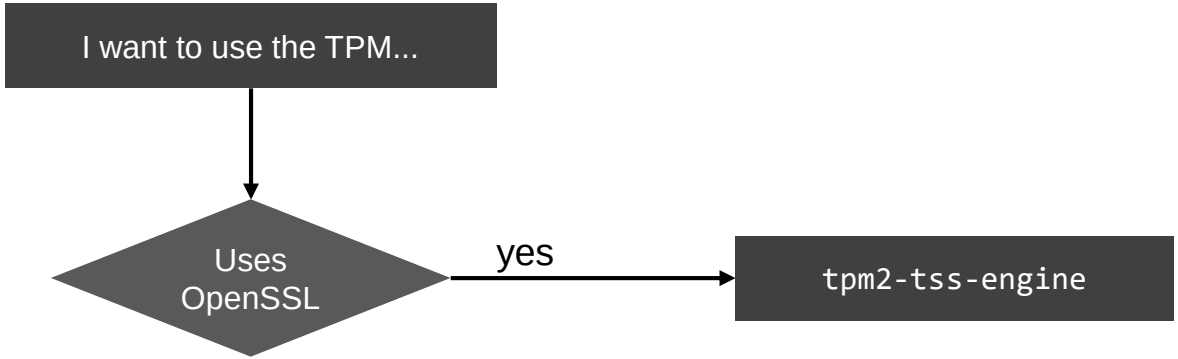


*no, we do not have a fancy name for the project and ecosystem

TPM – But How?



TPM – But How?



TPM – But How?

- Engine for OpenSSL: `tpm2-tss-engine`
- Create key

```
$ tpm2tss-genkey -a ecdsa mykey
$ openssl pkeyutl -engine tpm2tss -keyform engine -inkey mykey -sign -in mydata -out mysig
$ openssl pkeyutl -engine tpm2tss -keyform engine -inkey mykey -verify -in mydata -sigfile mysig
```

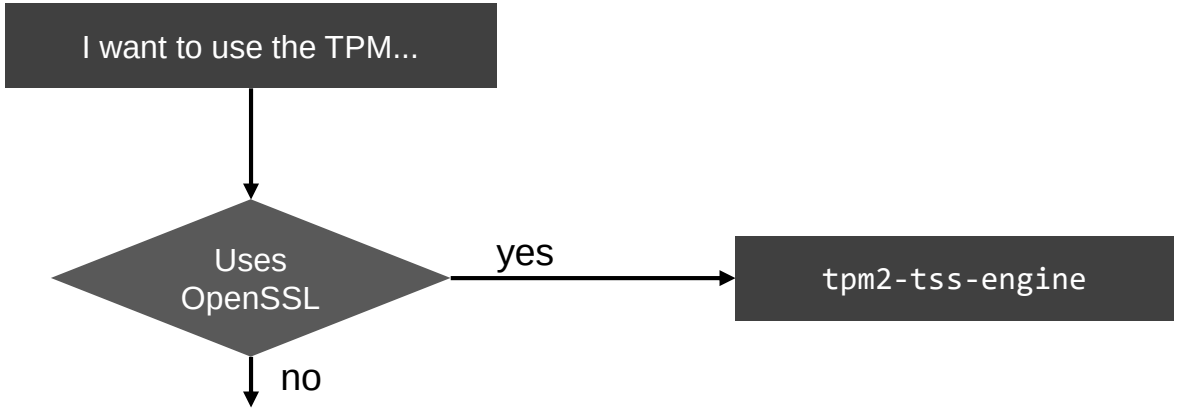
- Export the public key

```
$ openssl ec -engine tpm2tss -inform engine -in mykey -pubout -outform pem -out mykey.pub
```

- TLS Server? Sure!

```
$ ./tpm2tss-genkey -a rsa rsa.tss
$ openssl req -new -x509 -engine tpm2tss -key rsa.tss  -keyform engine  -out rsa.crt
$ openssl s_server -cert rsa.crt -key rsa.tss -keyform engine -engine tpm2tss -accept 8443
```

TPM – But How?



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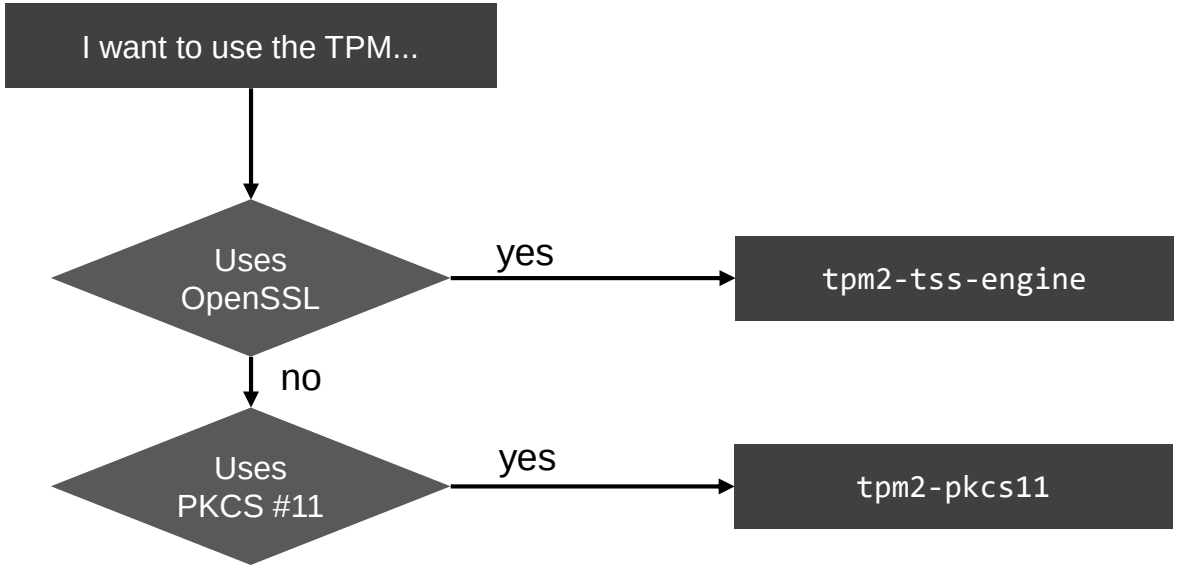


TPM – But How?

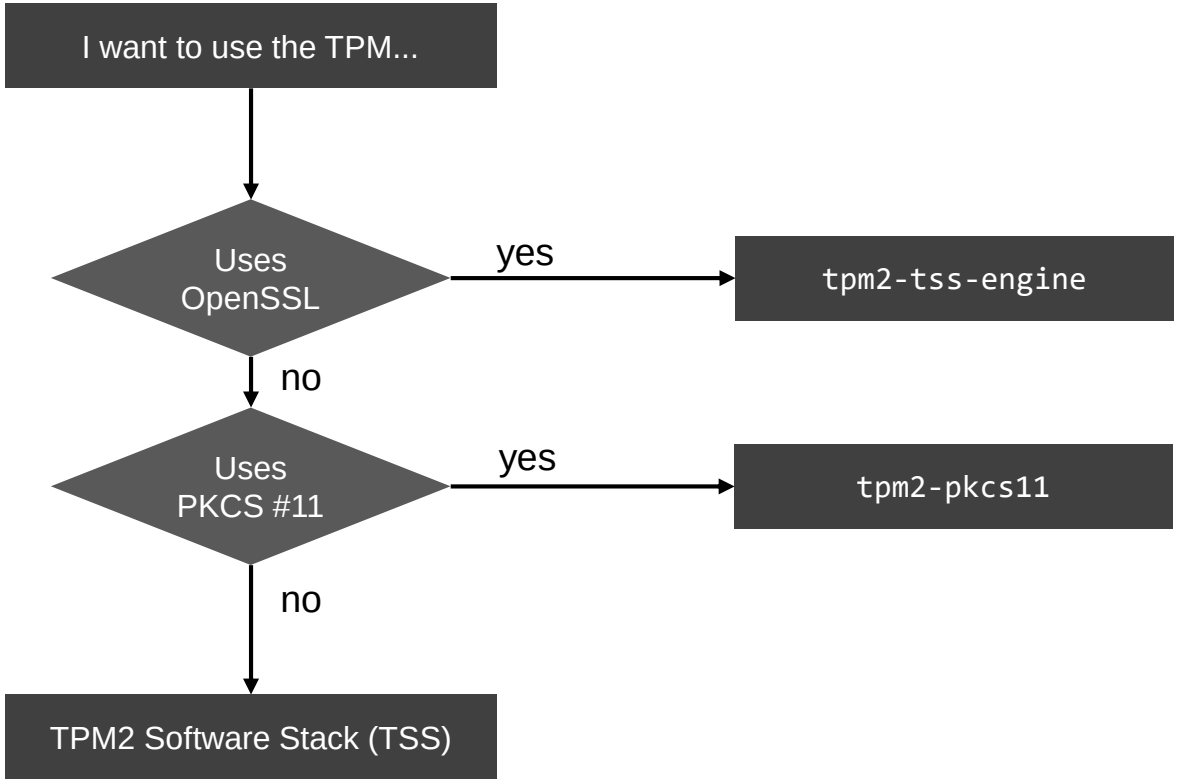
- PKCS #11 – Cryptoki
  - API for Smart Cards & other crypto tokens

- Supported by many widely-used applications
  - OpenSSH
  - OpenVPN
  - ...

- See the docs for examples:
  https://github.com/tpm2-software/tpm2-pkcs11/tree/master/docs

- If you integrate the TPM, tell us!

TPM – But How?



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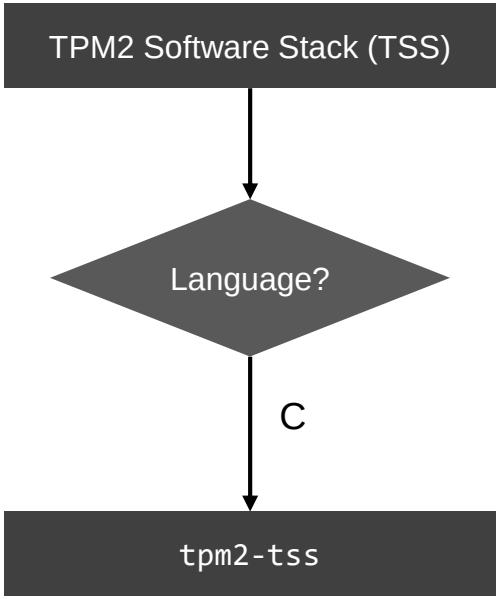

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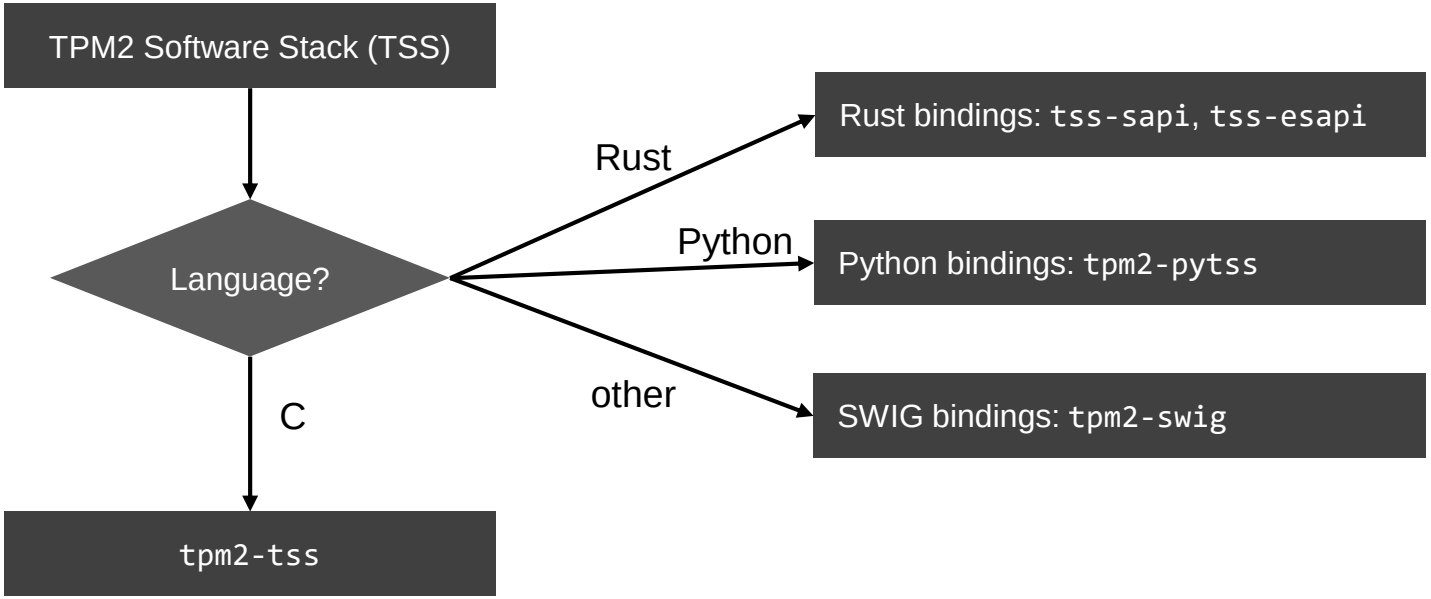

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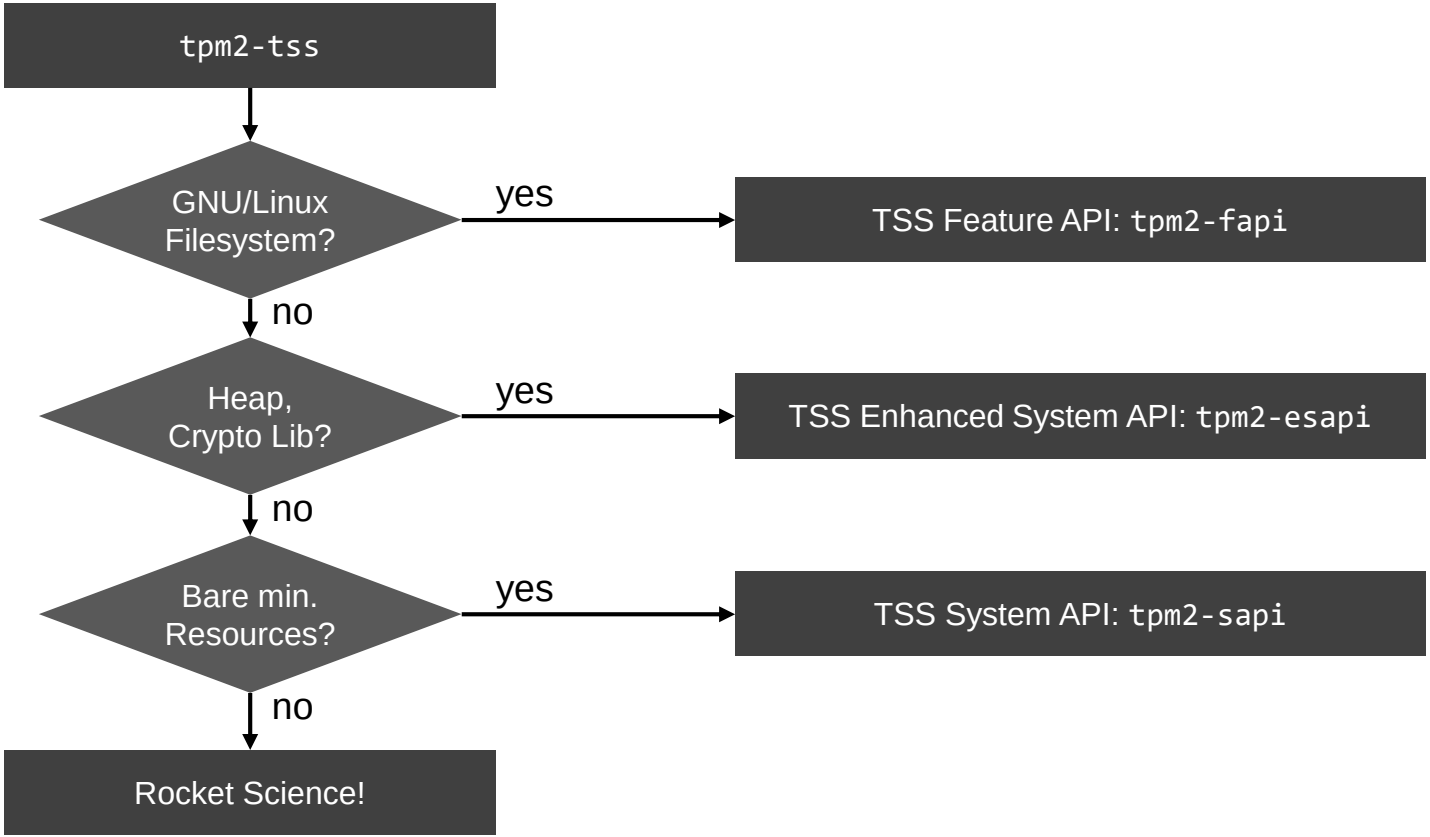


FAPI – Hello World!

› Install `tpm2-tss` (v2.4.0 or later)

› Configure the TSS:

`/etc/tpm2-tss/fapi-config.json`

```
{
    "profile_name": "P_ECCP256SHA256",
    "profile_dir": "/etc/tpm2-tss/fapi-profiles/",
    "user_dir": "~/tpm2-tss/user/keystore",
    "system_dir": "~/tpm2-tss/system/keystore",
    "tcti": "",
    "system_pcrs" : [],
    "log_dir" : "~/tpm2-tss/eventlog/"
}
```

FAPI – Hello World!

› A word about profiles...

... don‘t worry!

/etc/tpm2-tss/fapi-profiles/P_ECCP256SHA256.json

```
{
    "type": "TPM2_ALG_ECC",
    "nameAlg":"TPM2_ALG_SHA256",
    "srk_template": "system,restricted,decrypt,0x81000001",
    "srk_description": "Storage root key SRK",
    "srk_persistent": 0,
    "ek_template": "system,restricted,decrypt",
    "ek_description": "Endorsement key EK",
    "ecc_signing_scheme": {
        "scheme":"TPM2_ALG_ECDSA",
        "details":{
            "hashAlg":"TPM2_ALG_SHA256"
        },
    },
    ...
}
```

FAPI – Hello World!

- Use your tools!

  ... seriously, they‘re great for debugging!

- Install `tpm2-tools`
- Provision the TPM and the host

```
$ tss2_provision
WARNING:fapi:[...] Directory /home/alarm/tpm2-tss/eventlog/ does not exist, creating
WARNING:fapi:[...] Directory /home/alarm/tpm2-tss/user/keystore does not exist, creating
WARNING:fapi:[...] Directory /home/alarm/tpm2-tss/system/keystore/policy does not exist, creating
```

- List all objects (keys, policies, ...)

```
$ tss2_list
/P_ECCP256SHA256/LOCKOUT:
/P_ECCP256SHA256/HE:
/P_ECCP256SHA256/HE/EK:
/P_ECCP256SHA256/HN:
/P_ECCP256SHA256/HS:
/P_ECCP256SHA256/HS/SRK
```

FAPI – Hello World!

- Create a key

```
$ tss2_createkey --path "/P_ECCP256SHA256/HS/SRK/mySigningKey" --type "noDa,sign"
New password:
Re-enter new password:
```

- Sign...

```
$ openssl dgst -sha256 -binary -out myDigest.bin firmware.img
$ tss2_sign --keyPath "/P_ECCP256SHA256/HS/SRK/mySigningKey" \
      --digest myDigest.bin                                  \
      --publicKey mySigningKey_pub.pem                       \
      --signature mySignature.bin
```

- ... and verify

```
$ openssl dgst -verify mySigningKey_pub.pem -signature mySignature.bin firmware.img
  Verified OK
```

FAPI – Hello World

```c
#include <tss2/tss2_fapi.h>
#include <string.h>
#include <stdio.h>

int main(){
    TSS2_RC r = 0;
    size_t signatureSize = 0;
    uint8_t *signature;
    char *publicKey;
    size_t digestSize = 32;
    uint8_t digest[32] = {0x67, ..., 0x3e};

    FAPI_CONTEXT *fapi_context;
    r = Fapi_Initialize(&fapi_context, NULL);
    if (r != TSS2_RC_SUCCESS)
        goto error;

    r = Fapi_CreateKey(fapi_context, "HS/SRK/mySigningKey", "noDa, sign", "", "");
    if (r != TSS2_RC_SUCCESS)
        goto error;

...
```

FAPI – Hello World

```
 ...


    r = Fapi_Sign(fapi_context, "HS/SRK/mySigningKey", NULL, digest, digestSize, &signature,
                  &signatureSize, &publicKey, NULL);
    if (r != TSS2_RC_SUCCESS)
        goto error;

    Fapi_Finalize(&fapi_context);

    for (size_t i = 0; i < signatureSize; i++)
        printf("%02x", signature[i]);
    printf("\n");

    return 0;

error:
    Fapi_Finalize(&fapi_context);
    return 1;
}
```

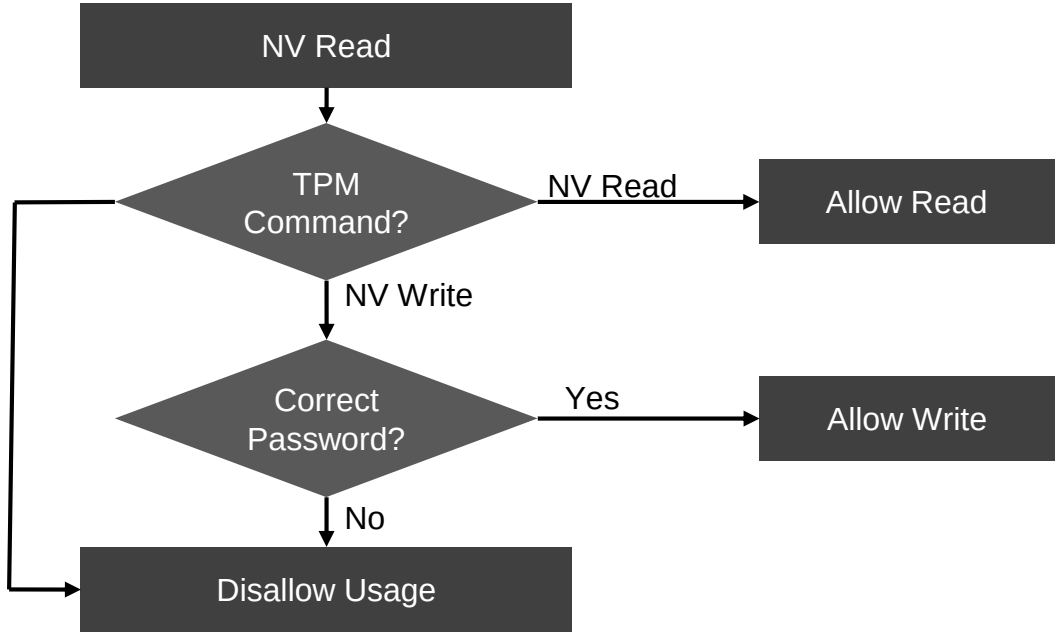
Enhanced Authorizations (EA) & Policies

- Fine grained access control mechanism to TPM entities
- A policy consists of one or more sub-policies
  - sub-policies can be combined via AND / OR
- “EA policies can become complex *very* quickly.” (A Practical Guide to TPM 2.0)

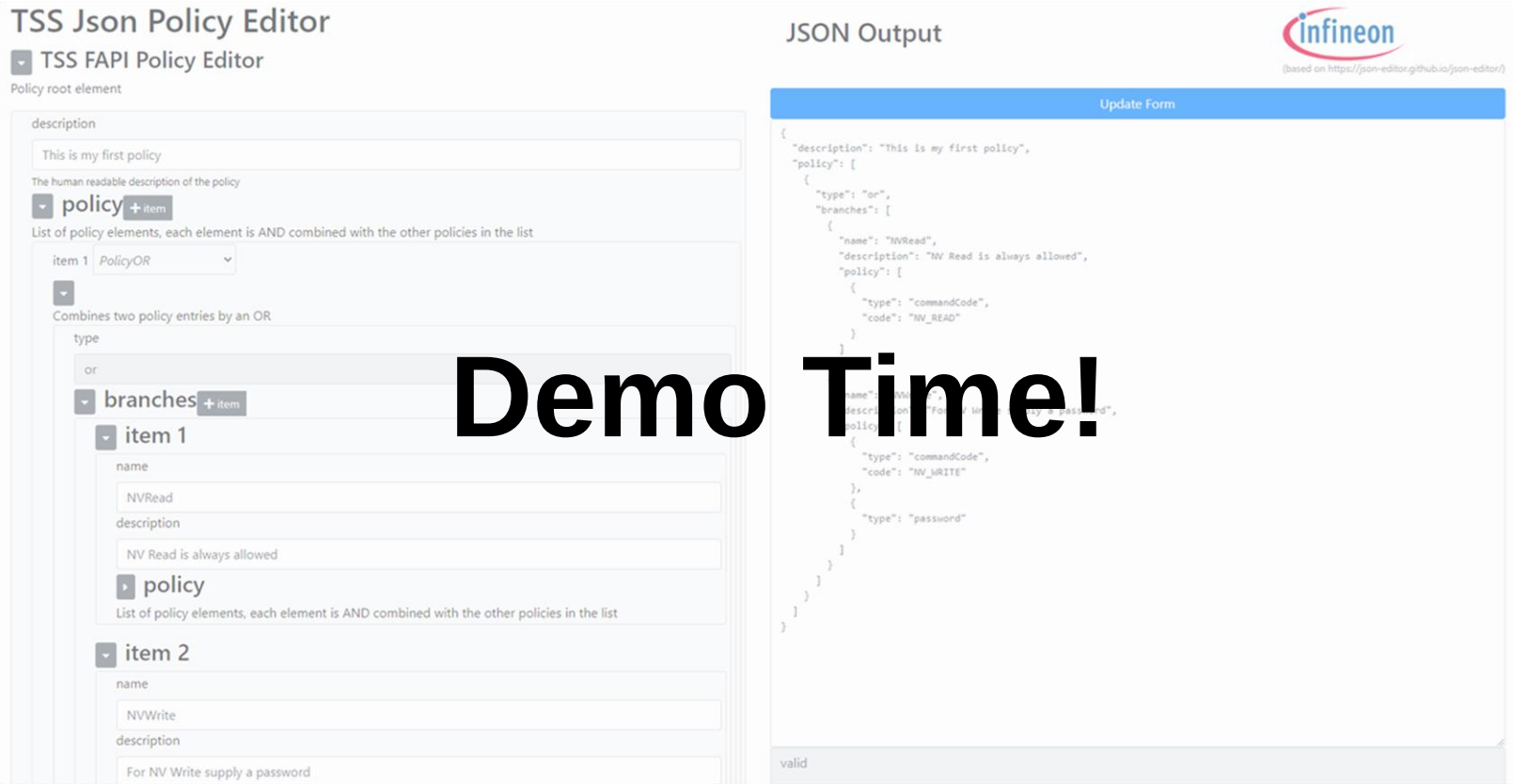
➡ Yet another complex TPM feature

Policies by Example

- chmod 446 nvindex (more or less)
  - Read for everyone
  - Write with correct password



Policies – TSS JSON Policy Editor



Demo Time!

Policies – Generated Example Policy

```
$ cat mynvpolicy.json
{
  "description": "A simple read write nv policy",
  "policy": [
    {
      "type": "or",
      "branches": [
        {
          "name": "NVRead",
          "description": "this is the read policy",
          "policy": [
            { "type": "commandCode", "code": "NV_READ“ }
          ]
        },
        {
          "name": "NVWrite",
          "description": "NV Write part - please supply a password",
          "policy": [
            { "type": "commandCode", "code": "NV_WRITE“ },
            { "type": "password" }
          ]
        }
      ]
    }
  ]
}
```

Policies – Usage with FAPI Tools

```
$ tss2_import -p /policy/nvtest -i mynvpolicy.json

$ tss2_createnv -p /nv/Owner/mynvtest -P /policy/nvtest  -s 64
New password: password
Re-enter new password: password

$ tss2_nvwrite -p /nv/Owner/mynvtest -i -
Hello OSSEU & ELCE!
Select a branch for /nv/Owner/mynvtest "PolicyOR"
   1 NVRead
   2 NVWrite
Your choice: 2
Authorize /nv/Owner/mynvtest "": password

$ tss2_nvread -p /nv/Owner/mynvtest -o –
Select a branch for /nv/Owner/mynvtest "PolicyOR"
   1 NVRead
   2 NVWrite
Your choice: 1
Hello OSSEU & ELCE!
```

Policies – Where to Start?

- TCG TSS JSON Policy Language Specification:
  https://trustedcomputinggroup.org/resource/tcg-tss-json

- Policies used in the TSS Repository:
  https://github.com/tpm2-software/tpm2-tss/tree/master/test/data/fapi/policy

- JSON Schema (WIP)
  https://github.com/PeterHuewe/TSS_JSON_Policy_Schema
  - Can be used by a JSON UI Editor
  - E.g. https://json-editor.github.io/json-editor
  - Great to explore TPM Policies

Looking for more fun with NV Indices and Policies?

Introducing TPM NV Storage with E/A Policies and TSS-FAPI - Andreas Fuchs, Fraunhofer SIT
October 29 • 14:40 - 15:25 @ LSSEU2020

What about Disk Encryption?

- TPM support on its way!
  - Initiated by Andreas Fuchs
  - PR #98 (by Ondrej Kozina, maintainer)
  - Will ship with release 2.4.0!

LUKS
Linux Unified Key Setup

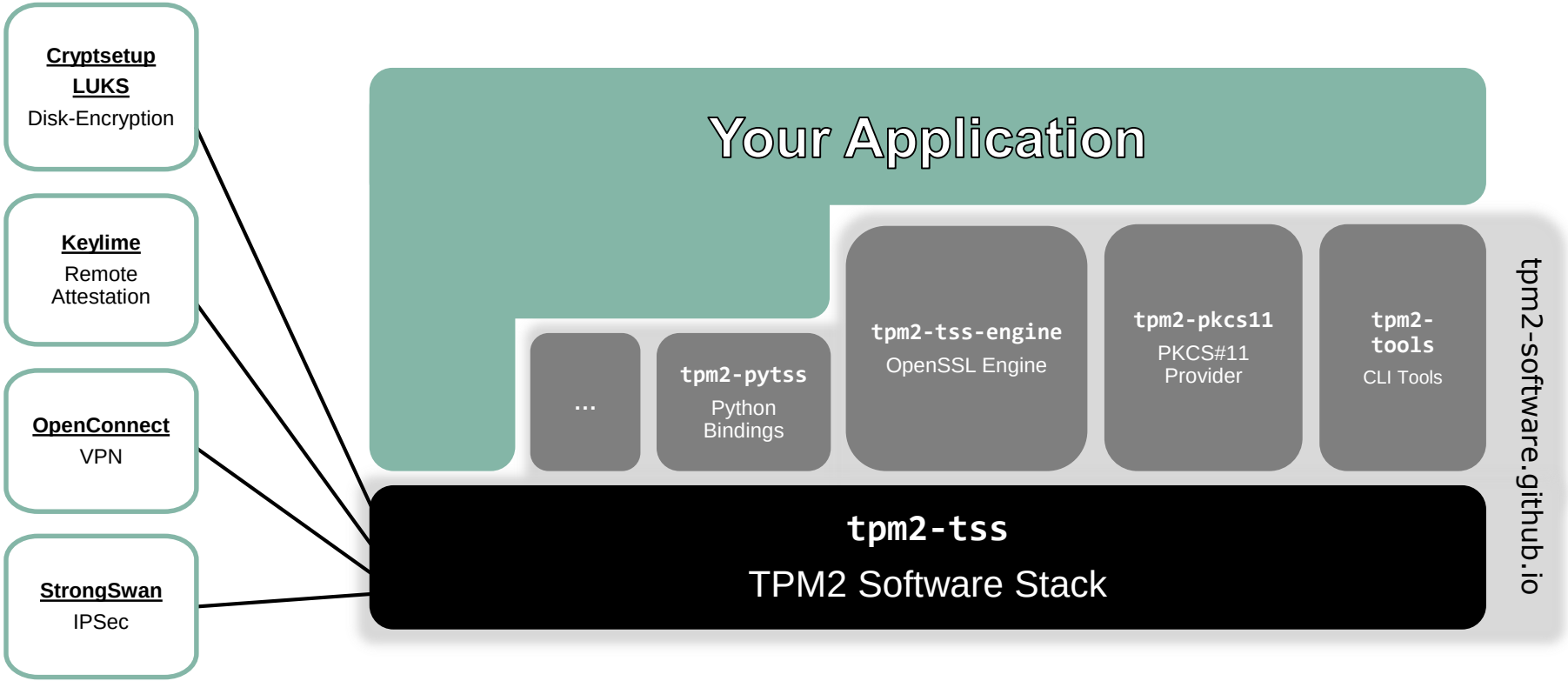
- Support for **loadable plugins**
  - TPM support built-in

- Bonus:
  - Completely new plugin system
  - Ease of integration for smart cards etc.

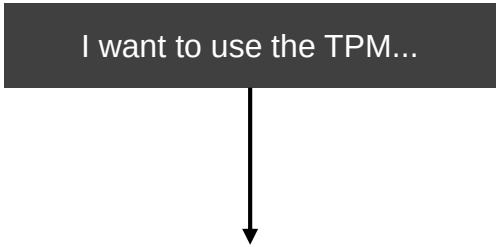
LUKS – A Sneak Peak

```
CRYPTSETUP-TPM2(8)                          Maintenance Commands                          CRYPTSETUP-TPM2(8)

NAME
       cryptsetup-tpm2 - tool for activating LUKS2 encrypted volumes using TPM2

SYNOPSIS
       cryptsetup-tpm2 <options> <action> <action args>

DESCRIPTION
       cryptsetup-tpm2  is  used  to  conveniently lock and activate LUKS2 volumes using a passphrase stored in a TPM
       2.0. TPM is a secure cryptoprocessor (similar to a smartcard) present in most of the recent laptops (and  some
       desktops).  cryptsetup-tpm2 stores metadata in a tpm2 token inside the tokens section of the LUKS2 header (see
       LUKS2 On-Disk Format Specification).

       This utility supports sealing the TPM key to a current HW/SW state. To fully utilize this feature, it  is  re-
       quired that the state is measured to the PCR banks by BIOS/UEFI, bootloader (e.g. TrustedGrub) and kernel (IMA
       subsystem).  If anything in the boot chain deviates from the pre-measured state, the passphrase won't  be  re-
       leased from the TPM.

       You can seal the passphrase to a specified PCR. They have the following meaning:

              PCR#0-7  Measured  by BIOS/EFI. includes measurement of items like boot options and order, microcode or
              secure boot status.

              PCR#16 Debug register

       In TrustedGrub2 PCRs contain the following measurements:

              PCR#8 First sector of TrustedGRUB2 kernel (diskboot.img)

              PCR#9 TrustedGRUB2 kernel (core.img)

              PCR#10 Loader measurements - currently linux-kernel, initrd, ntldr, chainloader, multiboot, module

              PCR#11 Contains all commandline arguments from scripts (e.g. grub.cfg) and those entered in the shell

              PCR#12 LUKS-header
:
```

Overview over the TPM Open Source Ecosystem



A Look into the Future...



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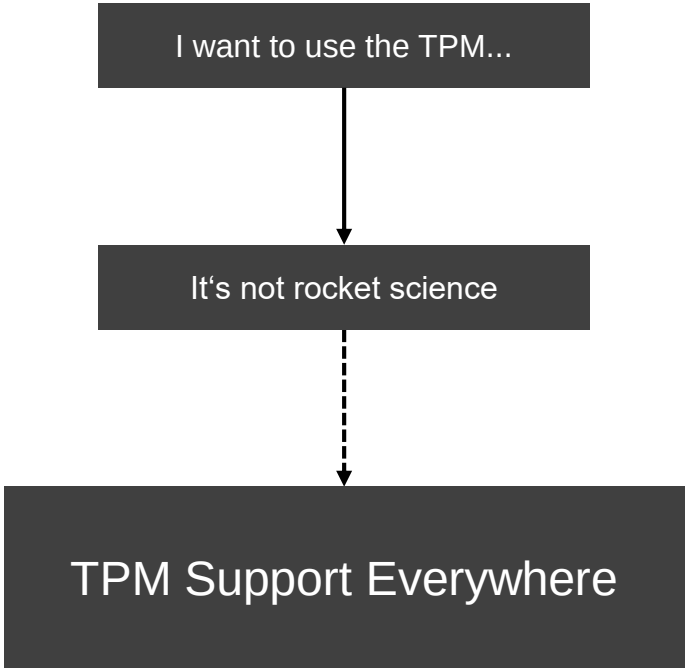

- Ubiquitous usage
  - Transparent
  - Easy to use
  - Secure keys for everyone
  - Secure platforms for everyone
- Similar to HTTPS / TLS
  - Nobody talks about this anymore
- For this we need your help!

Need Help? Want to Contribute?

Start at our GitHub Pages!
https://tpm2-software.github.io/

Mailing List
https://lists.01.org/postorius/lists/tpm2.lists.01.org/

Chat on Gitter
https://gitter.im/tpm2-software/community

IRC @ FreeNode
#tpm2.0-tss

Slack
https://tpm2-tss.slack.com

Let‘s Start Hacking!

On your Laptop...

```
$ ls /dev/tpm*
  /dev/tpm0  /dev/tpmrm0
```

... the Raspberry Pi...

IRIDIUM9670 by Infineon

... or a TPM simulator (development only)

SWTPM Simulator
github.com/stefanberger/swtpm

IBM TPM Simulator
https://sourceforge.net/projects/ibmswtpm2/

LetsTrust TPM

Questions?

Part of your life. Part of tomorrow.